Electroactive Functionalization of Graphene as Nanohybrid Materials for Redox Sensing and Energy Storage

Chi, Qijin; Zhu, Nan; Gan, Shiyu; Ulstrup, Jens; Zhang, Pifu

Publication date:
2014

Document Version
Publisher's PDF, also known as Version of record

université PARIS DIDEROT PARIS 7

Electrochemistry at the nanoscale from basic aspect to applications

ELECNANO6

chi's copy PROGRAMME

ElecNano[6]
26-28 may 2014
Paris, France

Electroactive Functionalization of Graphene as Nanohybrid Materials for Redox Sensing and Energy Storage

Qijin Chi, Nan Zhu, Shiyu Gan, Jens Ulstrup, and Pifu Zhang

Department of Chemistry, Technical University of Denmark, 2800 Kongens Lyngby, Denmark. (E-mail: cq@kemi.dtu.dk; Phone: +45 45252032)

As an atomic-scale-thick two-dimensional material, graphene has emerged as one of the most miracle materials and has generated intensive interest in physics, chemistry and even biology in the last decade.[1,2] Nanoscale engineering and functionalization of graphene is a crucial step for many applications ranging from catalysis, electronic devices, sensors to advanced energy conversion and storage.[3] In this talk, we *first* present a general theme for functionalization of graphene nanosheets, followed by showing our recent studies on electroactive functionalization of chemically exfoliated graphene materials and their potential applications in sensors, redox-based memory storage and supercapacitors. Our systems studied cover redox-active nanoparticles, electroactive supramolecular ensembles and redox enzymes which are integrated with graphene nanosheets and further transformed into thin films or graphene papers.[4-7] Figure 1 shows an example for preparation of *Prussian* blue nanoparticles (PBNPs) doped graphene oxide (GO) and reduced GO (RGO) papers.

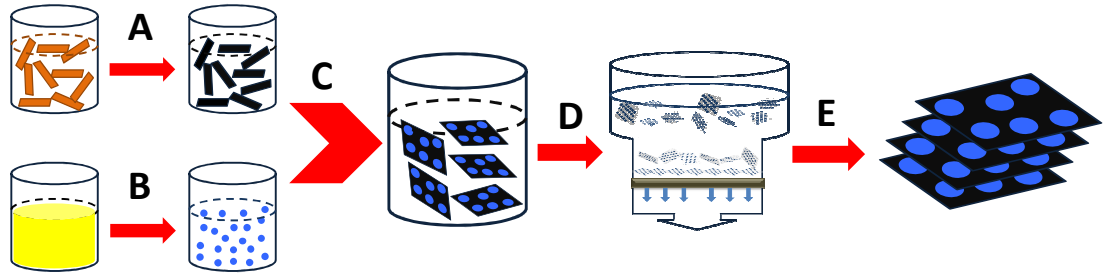

Figure 1. Schematic illustration of preparation of *electroactive, flexible* and *free-standing* graphene papers. A) Wet-chemical conversion of GO to RGO via hydrazine reduction, **B**) synthesis of PNBPs starting from the mixture of $FeCl_3$ and $K_4Fe(CN)_6$, **C**) preparation of PBNPs-RGO hybrid nanosheets, and **D**) and E) processes of preparing PBNPs-RGO hybrid paper including filtration, drying and annealing.[4] Not drawn to scale.

References

(1) M. J. Allen, V. C. Tung, R. B. Kaner, *Chem. Rev.* **2010**, *110*, 132.
(2) D. R. Dreyer, S. Park, C. W. Bielawski, R. S. Ruoff, *Chem. Soc. Rev.* **2010**, *39*, 228.
(3) Georgakilas, V. et al. *Chem. Rev.* **2012, *112***, 6156-6214.
(4) Gan, S. Y.; Zhong, L. J.; Wu, T. S.; Han, D. X.; Zhang, J.; Ulstrup, J.; Chi, Q.; Niu, L. *Adv. Mater.* **2012**, *24*, 3958-3964.
(5) Zhu, N.; Han, S.; Gan, S. Y.; Ulstrup, J.; Chi, Q. *Adv. Funct. Mater.* ***2013***, *23,* 5297-5306.
(6) Zhang, P.; Ulstrup, J.; Chi, Q. the manuscript in submission.
(7) Gan, S. Y.; Zhong, L. J.; Engelbrekt, C.; Zhang, J.; Han, D. X.; Ulstrup, J.; Chi, Q.; Niu, L. *Adv. Mater.* **2014**, the manuscript in submission.

Acknowledgements

This project is supported by the Danish Research for Technology and Product Science (Project No. 12-127447). S.Y.G. acknowledges the Universities Denmark for a visiting PhD studentship.